

NO-A183 830 GEOLOGICAL STRUCTURE OF THE SEMIPALATINSK REGION(U)  
FOREIGN TECHNOLOGY DIV WRIGHT-PATTERSON AFB OH  
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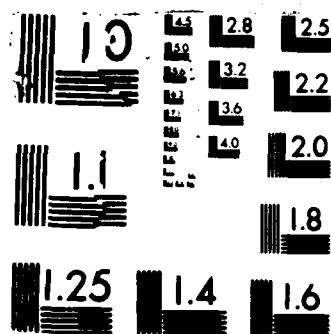
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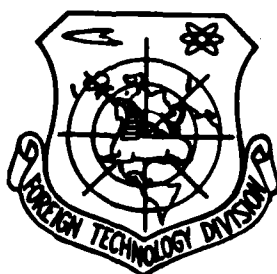
# FOREIGN TECHNOLOGY DIVISION



GEOLOGICAL STRUCTURE OF THE SEMIPALATINSK REGION

by

N.A. Sevryugin



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# PARTIALLY EDITED MACHINE TRANSLATION

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10 August 1987

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GEOLOGICAL STRUCTURE OF THE SEMIPALATINSK REGION

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Translation # FTD-ID(RS)T-0204-86 (Provided by SIT)

Foreign Page # \_\_\_\_\_

Incorrect word/phrase: \_\_\_\_\_

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Foreign page numbers occur in the English text and may be found anywhere along the left margin of the page as in this example:

In them occurs the state named "night blindness" - hemeralopia, which, according to the current point of view, is a result of damage of the rod-shaped apparatus of the eye.

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However, in recent years it has been shown that with the hereditary pigment degenerations in animals the biochemical changes are observed in all cellular elements of the retina.

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Recommendation: \_\_\_\_\_

# U. S. BOARD ON GEOGRAPHIC NAMES TRANSLITERATION SYSTEM

Block	Italic	Transliteration	Block	Italic	Transliteration
А а	<i>А а</i>	A, a	Р р	<i>Р р</i>	R, r
Б б	<i>Б б</i>	B, b	С с	<i>С с</i>	S, s
В в	<i>В в</i>	V, v	Т т	<i>Т т</i>	T, t
Г г	<i>Г г</i>	G, g	У у	<i>У у</i>	U, u
Д д	<i>Д д</i>	D, d	Ф ф	<i>Ф ф</i>	F, f
Е е	<i>Е е</i>	Ye, ye; E, e*	Х х	<i>Х х</i>	Kh, kh
Ж ж	<i>Ж ж</i>	Zh, zh	Ц ц	<i>Ц ц</i>	Ts, ts
З з	<i>З з</i>	Z, z	Ч ч	<i>Ч ч</i>	Ch, ch
И и	<i>И и</i>	I, i	Ш ш	<i>Ш ш</i>	Sh, sh
Й й	<i>Й й</i>	Y, y	Щ щ	<i>Щ щ</i>	Shch, shch
К к	<i>К к</i>	K, k	Ъ ъ	<i>Ъ ъ</i>	"
Л л	<i>Л л</i>	L, l	Ы ы	<i>Ы ы</i>	Y, y
М м	<i>М м</i>	M, m	Ь ь	<i>Ь ь</i>	'
Н н	<i>Н н</i>	N, n	Э э	<i>Э э</i>	E, e
О о	<i>О о</i>	O, o	Ю ю	<i>Ю ю</i>	Yu, yu
П п	<i>П п</i>	P, p	Я я	<i>Я я</i>	Ya, ya

\*ye initially, after vowels, and after Ъ, Ь; e elsewhere.  
When written as ѣ in Russian, transliterate as yě or ě.

## RUSSIAN AND ENGLISH TRIGONOMETRIC FUNCTIONS

Russian	English	Russian	English	Russian	English
sin	sin	sh	sinh	arc sh	$\sinh^{-1}$
cos	cos	ch	cosh	arc ch	$\cosh^{-1}$
tg	tan	th	tanh	arc th	$\tanh^{-1}$
ctg	cot	cth	coth	arc cth	$\coth^{-1}$
sec	sec	sch	sech	arc sch	$\operatorname{sech}^{-1}$
cosec	csc	csch	csch	arc csch	$\operatorname{csch}^{-1}$

Russian      English

rot      curl  
lg      log

## GRAPHICS DISCLAIMER

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## GEOLOGICAL STRUCTURE OF THE SEMIPALATINSK REGION.

N. A. Sevryugin.

As a result of the 1:200 000 scale geological survey conducted during 1954—1958 it has been established that the Near-Semipalatinsk region belongs mainly to the Zaisan-Irtish Hercynian intrageosyncline; and only a narrow strip in the south-west refers to the Bayanaul-Chingiz middle block mass (geanticline of the first order). Within the latter the following faunistically characterized deposits have been distinguished in accordance with their stratigraphic relations: the Proterozoic, Ashgill, Lower-Middle Devonian; the Mesozoic weathering crust; the Middle Cambrian, Upper Cambrian, Tremadoc, Lower Middle and Upper Ordovician, Lower Silurian, Lower-Upper Silurian; the Frasnian and Famennian Stages; the Tournaisian and Lower-Visean stages. Within the Zaisan-Irtish intrageosyncline area the following faunistically characterized deposits have been established: the Silurian, Lower-Middle Devonian; the Frasnian and Famennian stages; the Tournaisian, Lower Visean, Middle and Upper Visean, Upper Visean-Namurian stages; the Middle Carboniferous, Middle-Upper Carboniferous, Upper Carboniferous—Lower Permian, Upper Eocene, Lower and Middle Miocene, Middle and Upper Miocene and Upper Neogene. Multi-Phase intrusive complexes also have been distinguished here: the Lower Paleozoic, Late Caledonian; the Upper Visean (ultrabasic); the Early, Middle and Late Upper Paleozoic. Each of these complexes is characterized by a peculiar metallogenetic specialization.

The Semipalatinsk region is located between Kalboy and the Chingiz range and extends in the southeastern direction from the settlement of Semiyarsk on the Irtysh River almost to Lake Zaysan. (Fig. 1).

Systematic geological study of the Semipalatinsk region was begun in 1954 by geologists of the Kazakh Geological Administration and continues at present with participation of geologists of other organizations. During this period a whole series of new layers and promising areas with the ore manifestations of mercury, rare and trace elements, gold, molybdenum, polymetals, tin, titanomagnetite, coal, piezo-optical raw materials and construction materials has been discovered here.

According to new data, the Semipalatinsk region is located in



limits of two sharply different structural-facies zones (Fig. 2). In essence it enters into the Zaysan-Irtysh Hercynian intra-geosynclinal zone (according to V. A. Nikolayev, first-order geosyncline), and only on southwest in the form a narrow strip it is stretched in the Bayanaul-Chingiz zone of hard mobile block (according to V. A. Nikolayev - middle mass or geoanticlinal first-order zone).

Between the Zaysan-Irtysh intrageosynclinal and Bayanaul-Chingiz mobile block passes the Kalbo-Chingiz deep fault and zone of crumpling accompanying it.

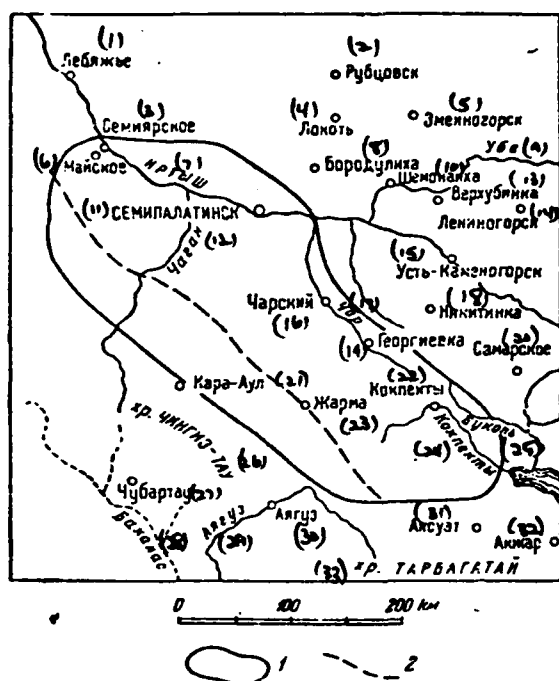


Fig. 1. Survey map of the Semipalatinsk region. 1 - outline of the Semipalatinsk region, 2 - Kalbo-Chingiz fault - southwestern boundary of the Zaysan-Irtysh Hercynian intra-geosyncline.

Key: (1). Lebyazh'ye. (2). Rubtsovsk. (3). Semiyarskoye. (4). Lokot'. (5). Zmeinogorsk. (6). Mayskoye. (7). Irtysh. (8). Borodulikha. (9). Uba. (10). Shemonaikha. (11). Semipalatinsk. (12). Chagan. (13). Verkhubinka. (14). Leninogorsk. (15). Ust'-Kamenogorsk. (16). Charskiy. (17). Char River. (18). Nyakitinka. (19). Georgiyevka. (20). Samarskoye. (21). Kara-Aul. (22). Kokpekty. (23). Zharma. (24). Kokhpekty R. (25). Bukol'. (26). Chingiz-Tau Range. (27). Chubartau. (28). Bakhanas. (29). Ayaguz. (30). Ayaguz R. (31). Aksuat. (32). Akzhar. (33). Tarbagatay Range.

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Rocks of the Zaysan-Irtysh intra-geosyncline have on the whole a northwestern stretch and monoclinal incidence/drop on northeast. In the southwestern part of the intra-geosyncline are established/installed sufficiently large/coarse anticlinal folds (Koyandinsk) and series of the deep faults of northwestern (Charskiy zone of faults) and sublatitudinal (Arkalyusk zone of faults) stretches, the accompanied by zones crumplings. In the axial zone of the sagging of the Zaysan-Irtysh intra-geosyncline Charsk internal second-order geoanticline clearly is separated/liberated.

Rocks of the Bayanaul-Chingiz mobile block are rumpled mainly into brachy- folds. Only deposits of the middle Cambrian and Proterozoic, which make up the Naymandzhal-Ashchisuysk and Alkamergen'-Dzhelandinsk anticlinorium, form the strip elongated in the northwestern direction.

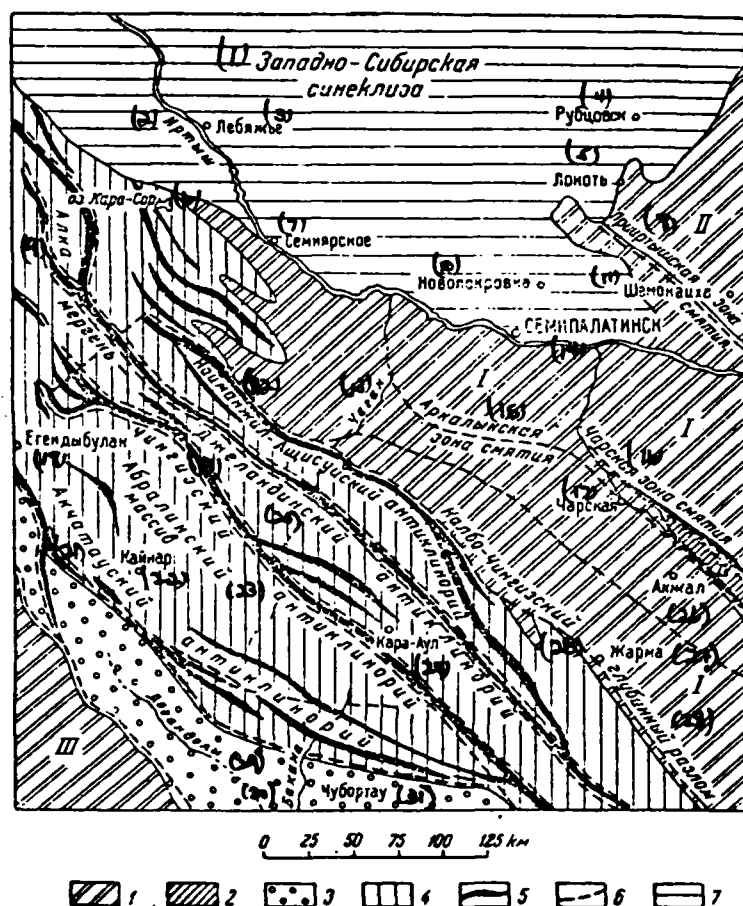


Fig. 2. Diagram of geotectonic structures of northeastern Kazakhstan. 1 - Hercynian intra- and the parageosyncline: I - Zaysansk intra-geosyncline (according to V. A. Nikolayev first-order geosyncline), II - Rudno-Altai parageosyncline (second-order geosyncline), III - Dzhungaro-Balkhash intra-geosyncline (first-order geosyncline); 2 - Charsk internal second-order geoanticline (IV); 3 - transition zone of the Dzhungaro-Balkhash intra-geosyncline; 4 - Bayanaul-Chingiz mobile block (middle mass or geoanticlinal first-order zone); 5 - predominant stretches of anticlinorium of lower Paleozoic period and pre-Paleozoic; 6 - regional faults and the zone

of displacement; 7 - Mesocenozoic saggings/deflections.

Key: (1). Western- Siberian syncline. (2). Irtysh. (3). Lebyazh'ye. (4). Rubtsovsk. (5). Lokot'. (6). Lake Kara-Sor. (7). Semiyarskoye. (8). Irtysh zone of crumpling. (9). Alka-Mergen' (10). Novopokrovka. (11). Shemonatskhe. (12). Naimanzhal-Ashchisuis anticlinorium. (13). Chagan. (14). Semipalatinsk. (15). Arkalyksk zone of crumpling. (16). Charskaya zone of crumpling. (17). Charskaya. (18). Yegendybulak. (19). Chingiz. (20). Dzhelandinskiy anticlinorium. (21). Akchatausk. (22). Kaynar. (23). Abralinsk massif. (24). Kara-Aul. (25). Kalbo-Chingiz. (26). Akzhal. (27). Zharma. (28). deep fault. (29). Dagandely. (30). Bakanas. (31). Chubortau.

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On the area of the Bayanaul-Chingiz mobile block the disjunctive disturbances/breakdowns, which divide/mark off it into whole series of runners, which experienced repeated lowerings and raisings with the formation of horsts and grabens, are widely developed. This specificity of the historical development of each of the noted above structural-facies zones caused the uniqueness of their geological structure.

For Bayanaul-Chingiz mobile block are characteristic the brachy-fold, or chest form of folds, very wide development of disjunctive disturbances/breakdowns, volcanic and intrusive activity, and in connection with this and hydrothermal processes. Furthermore,

for it are characteristic the low thicknesses of terrigenous deposits and the increased thickness of effusive-tufagenic formations and also the paleogeographic rearrangement of territory, the presence of ancient - conditionally Proterozoic - species/rocks and the wide acceptance of the deposits of lower and average Paleozoic period.

For Zaysan-Irtysh intra-geosyncline are characteristic self-possessed linear form of folds, wide development of sea terrigenous formation/educations, weak development of effusive and intrusive activity, large thickness of deposits, uniqueness of minerals of remainders/residues, absence of outcrops to topographic surface of Precambrian and Lower Paleozoic deposits, but good nakedness middle- and Upper Paleozoic.

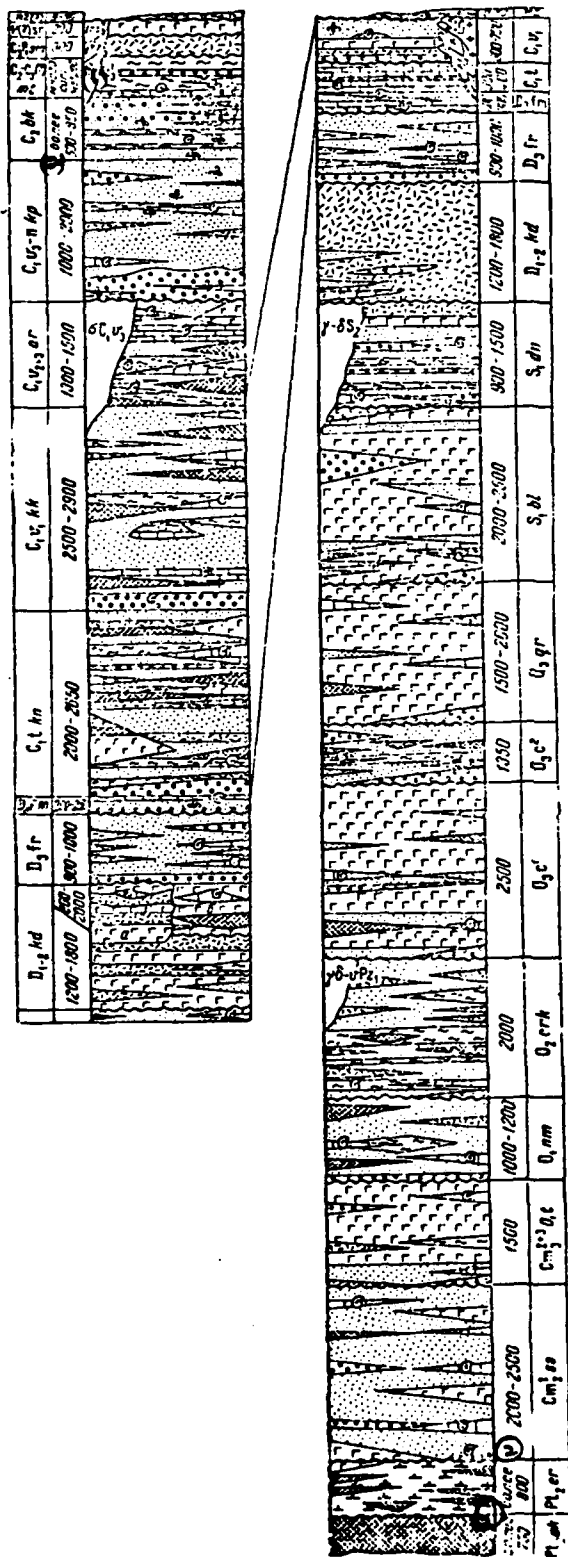


Fig. 3.

Fig. 3. Comparison of stratigraphic sections/cuts. To the left - southwest Zaysan-Irtysh intra-geosyncline, to the right - the northeast. Bayanaul-Chingiz zone.

Key: (1). there are many hundred meters. (2). it is more.

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Fig. 3 gives stratigraphic sections/cuts of the semipalatinsk region, in development of which they participated: N. A. Sevryugin, M. B. Mychnik, M. M. Marfenkova, N. P. Voronov, Yu. A. Stolyarov, K. T. Kulikovskiy, A. V. Stepanov and a whole number of other geologists for Kazakh geological administration.

Upper Proterozoic is isolated conditionally. The formation/educations of this age are encountered only in the northwestern part of Naymandzhal of ASHchISUYS anticlinorium and are dismembered to two formations: lower - Akdymsk and upper - Yeremen'tau.

In the Akdymsk formation<sup>1</sup> are included: multicolored jasper-quartzites, quartzites, micro-quartzites and sericite-siliceous schists.

FOOTNOTE <sup>1</sup> The Akdym formation or series (lower part of the upper Proterozoic) is isolated on the Akdym mountain (northeast of central Kazakhstan) by R. A. Borukayev in 1957. The information about it is published in the theses of reports "Conference on the unification of



the stratigraphic diagrams of the pre-Paleozoic and Paleozoic period of East Kazakhstan", Alma Ata, 1957. ENDFOOTNOTE.

The thickness of formation is more than 750 m. The Yeremen'tau formation is folded by greenish-gray albite-chlorite-actinolite, quartz sericitic, quartz-chloritic and siliceous-clay schists, by porphyriteides, strongly changed with porphyrites and their tuffs/tufas with the seams of jasper-quartzites, marbled limestones and changed sandstones. The thickness is more than 800 m.

Interrelation of the Akdym and Yeremen'tau formations is not established. However, by analogy with the adjacent regions (Bayanaul and Boshchekul') it is possible to assume that the Yeremen'tau formation with the angular disagreement will lie the Akdym. The age of these formations is defined conditionally as Upper Proterozoic. It served as a basis for this conclusion: 1) formations will lie in the base of the cross section; 2) on them with the angular disagreement are arranged/located the faunistically described deposits of the Sasyksorsk formation of average Cambrian; 3) the species/rocks of formations underwent the intensive action of the processes of regional and dislocatory metamorphism; 4) the similarity/resemblance of the sections/cuts of the described deposits to the section/cut of the Upper Proterozoic deposits, developed in the adjacent regions.

Deposits of lower Cambrian as a result of absence of findings of minerals of remainders/residues of this period are not isolated. It

is possible that during more detailed studies they will be isolated in the southwestern part of the described region.

The middle Cambrian is the Sasyksorsk formation. The deposits of the latter are widely developed in the limits of Naymandzhal of Ashchisu and Alkamergen'-Dzhelandinsk anticlinorium, where they with the angular disagreement will lie on the conditionally chosen Upper Proterozoic formation/educations. In formation are included: dark green and reddish brown mainly fine-grained sandstones and clay shales and rarely encountered horizons/levels of jasper-quartzites, siliceous-clay and chlorite-siliceous schists, porphyrites and their tuffs/tufas, albitophyres, conglomerations and light grey marbled limestones with fauna. Thickness of approximately 2000-2500 m.

Age of Sasyksorsk formation is established/installed on mineral organic remainders/residues, assembled by the author in 1954-1955 in region of left bank of the river Ashchisu and by M. B. Mychnik in 1956 in region of left bank of the river Mamysu as the upper half of the middle Cambrian. The list of the mineral organic remainders/residues (determination of trilobite executed by N. K. Ivshin, brachiopod - by I. F. Nikitin) is given below: *Solenopleura lata* Ivsh., *S. suavis* Ivsh., *Semisphaerocerhalus nominalis* Ivsh., *Anomocape* ex gr. *salaiensis* Lerm., *Pseudagnostus ethyl alcohol*, *Diplagnostus* sp., *Aldanaspis* aff. *punctatus* Lerm., *Nisusia montanensis* var. nov., *Nisusia montanensis* Bell., *Peroonsis fallom* (Linnars), *Hypagnostus* ex. gr. *brevifrons* Ang.

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Upper Cambrian-lower Ordovician is species/rocks of the Tortkuduksk formation, developed within limits of southeastern part of Aklamergen'-Dzhelandinsk anticlinorium (mountains Ittumsyk, Kyzylshoky and Kyzylbiik), and also encountered in Naymandzhal-Ashchisu anticlinorium, where fauna in its deposits is not found. The species/rocks of Tortkuduksk formation with the angular disagreement will lie on the deposits of average Cambrian. Into its composition enter: amygdaloidal, quartz and pyroxenic porphyrites and their tuffs/tufas, diabases, sandstones, conglomerations, aleurolites, are less frequent than the lens of limestones and tuffs/tufas of acid effusions. Thickness of formation is approximately 1500 m.

In 1956 in the region of Ittumsyk mountains M. B. Mychnikom from limestones and calcareous lower horizon/level were sandstone assembled mineral organic remainders/residues: *Billingsella* ex gr. *fluctuosa* I Nik., *Billingsella* sp. nov., *Finkelburgia* sp. N 1, *F* sp. N 2, *F* sp. N 3, *Eoorthis*? sp., *Aphelaspis* sp., *Proceratoryge* sp. According to determinations of I. F. Nikitin and N. K. Ivshin, this fauna indicates the upper Nekzhembriysk age of its consisting deposits. In the very tops of the section/cut of formation in the calcareous sandstones they are assembled: *Asaphus* sp., *Basilicus* sp., *Ogigites* sp., *Archaeorthis* sp., *Syntrophicidea*, that indicate the Lower Ordovician age of deposits. Thus, the age of Tortkuduksk formation is defined as upper Cambrian - Tremadok

Ordovician is widely developed within limits of Bayanaul-Chingiz mobile block and is the Naymansk formation (Arenig), of the Yerkebidaik formation (Landeylo), lower-Caradocian substage, upper-Caradocian substage and Zharsorsk formation (ASHgiliy).

The Naymansk formation <sup>1</sup> is encountered only in Kochaly mountains, also, beyond limits of the Semipalatinsk region in Akirek mountains, where it with angular disagreement will lie on species/rocks of the Tortkuduksk formation of upper Cambrian-Tremadok.

FOOTNOTE<sup>1</sup>. The Naymansk formation of Arenigsk stage is isolated on the natural boundary of Nayman in Chingiz range of R. A. Borukayev in 1957. ENDFOOTNOTE.

In the formation they are included: the greenish-gray to brownish red siliceous schists, argillites, sandstones, the interlayers of tuffs/tufas of acid composition, and also the lens of calcareous sandstones and limestones. In the base of formation the horizon/level of conglomerations will lie. Thickness is approximately 1000-1200 m.

In the Semipalatinsk region of minerals of remainders/residues in the Naumansk formation it is not discovered. Its Arenigsk age is determined on the finding of fauna in the middle part of the analogous deposits) of Akirek (in adjacent region mountain, where by M. B. Mychnik in 1956 they are found: *Protopleomerops cf deferrarisi* Harr.,

Apatosephalus aff. replicare Lis., Apatosephalus sp., Archaeorthis? sp., Pomatotrema? sp., Obolus sp.

It is necessary to note that on this fauna by paleontologists of M. N. Koroleva and K. A. Lisogor was initially defined age of species/rocks as Tremadoksk, and it is later, when fauna was by them reviewed, as Arenig.

The Yerkebidaiksk formation is sufficiently widely developed in limits of the Bayanaul-Chingiz mobile block, where it composes the mountains of Aygyrzhal, Karaadyr and Ordatas. This formation with the angular disagreement and the horizon/level of basal conglomerations will lie on the deposits of upper Cambrian-Tremadok. In the Yerkebidaiksk formation are included the interbedded horizons/levels of greenish-gray sandstones, aleurolites, argillites, tuffites, tuffs/tufas, quartz albitophyres, and less frequent, albitophyres and porphyrites. In the base of formation the horizon/level of conglomerations will lie. The thickness is approximately 2000 m.

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Age of described formation on obtained in it mineral organic remainders/residues Soerbyella sp., Chasmotopora sp., Rhinidictye sp., Cliftonia ex gr. spiriferoides (M'Coy), Rhynchotrema sp., Sowerbyella ex gr. sericea (Sow.), defined by M. N. Koroleva, from known by fraction/portion conditionality is established as Landeylo. This fauna is gathered in 1956 by M. B. Mychnik in the calcareous

sandstones and aleurolites to the south from the Ordotas mountains. this formation overlaps with the angular disagreement with the deposits of lower-Caradocian substage with the horizon/level of basal conglomerations how is confirmed the age, defined as Landeylo.

Lower Paleozoic intrusive complex, which has the Semipalatinsk region insignificant development, is species/rocks, component/term small intrusions, which break through Proterozoic and lower Paleozoic formations. Upper boundary of these intrusions dependent on age is determined by the fact that component/term the complex of species/rock frequently are encountered in the pebbles of the conglomerations of lower Karadok and younger formation/educations. In Lower Paleozoic intrusive complex are included: dioritic porphyrites, quartz dioritic porphyrites, microdiorites, granodiorite, diorite, quartz diorite and sometimes gabbro-diorites.

Lower-Caradocian substage is widely developed in the Bayanaul-Chingiz mobile block, where its deposits with horizon/level of basal conglomerations in base will lie with angular disagreement on Yerkebidaiksk formation Landeylo. In lower-Caradocian substage are included: diverse porphyry and their tuffs/tufas, less frequently tufagenic conglomerations, sandstones, aleurolites and marbled limestones with total thickness about 2500 m. The age of these deposits is defined on the position in the stratigraphic section/cut and the mineral organic remainders/residues Remopleurides cf pisiformis Web, Harpes ex gr. costatus Ang., Pliomera sp.,

Remopleurides sp., Triplecia sp., Pactorthidae as lower Karadok. This fauna is assembled in 1956 by M. V. Mychnik in the southeastern spurs of Aygyrdzhal mountain and is determined by M. N. Korolevoy.

Upper-Caradocian substage has limited development and is encountered in region of the mountains of Ittumsyk and Donenzhal, after lying with angular disagreement on deposits of lower-Caradocian substage. In this substage are included: greenish-gray polymict sandstones and aleurolites, less frequently the conglomerations, the horizons/levels of jasper-quartzites and lens of limestones with the fauna. Limestones are frequently quartzized. The weak horizons/levels of porphyrites and their tuffs/tufas very rarely are encountered. In the base of the section/cut of upper-Caradocian substage the thinned out horizon/level of conglomerations will lie. Thickness of the deposits of upper-Caradocian substage of approximately 1350 m. Their age on the mineral organic residues gathered in 1956 by M. B. Mychnik in the region of the mountains Sulucheky and Donenzhal, is established/installed as upper Karadok. Given below is the list of the mineral organic remainders/residues of the trilobite (determination of M. N. Oroleva) obtained here and brachiopod (determination of T. B. Rukavishnikova): *Dinorthis* (*Plaesiomis*) sp., *Christiania* ex gr. *tenuicincta* M'Coy, *Dulanaspis levis* Tschug., *Remopleurides pisiformis* Web., *R. salteri* var. *girvanensis* Reed, *Geraurus jakovlevi* Tschug., *Sphaeroxochus hisingeri* Warb., *Claphurina weberi* Tschug.? *Harpes* sp.

The Zharsorsk formation is encountered only in wings of southeastern part of Alkamergen'-Dzhelandinsk anticlinorium, where it with angular disagreement and horizon/level of basal conglomerations in base will lie on upper-Caradocian deposits, composing the mountains Ot'yar Beschoky, Bokaly, and others. In the formation are included: diverse porphyrites and their tuffs/tufas, the rarely encountered horizons/levels it is sandstone, aleurolites, conglomerations, the lens of jasper-quartzites and limestones. Thickness of formation 1500- 2000 m. Its age is determined by the stratigraphic position between faunistically described upper Karadok and lower Silurian (Llandoveryan stage).

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Deposits of Silurian are sufficiently widely developed within limits of Bayanaul-Chingiz mobile block and are two formations: Balyktinsk (lower Silurian) and Donenzhal'sk (lower - upper Silurian).

Balyktivnsk formation <sup>1</sup> has wide development.

FOOTNOTE <sup>1</sup>. Balyktinsk formation of lower Silurian is isolated on the river Balykty in the northern spurs of Chingiz range by M. V. Mychnik in 1956. ENDFOOTNOTE.

It contains in the base the horizon/level of basal conglomerations and will lie with the angular mismatch on the Zharsorsk formation of Ashgill and the more ancient formations. In formation are included:



greenish-gray and violet hornblende, pyroxenic, diabasic less frequently less frequent amygdaloidal porphyrites and their tuffs/tufas, greenish-gray and red-colored sandstones, aleurolites and conglomerations. The horizons/levels of albitophyres, their tuffs/tufas and lens of limestones are rarely encountered. Thickness of formation of approximately 2000-2500 m. For the species/rocks of Balyktinsk formation rapid facies changeability on the stretch and the incidence/drop is characteristic. By M. B. Mychnik in 1956 in the region of the mountains of Kul'kaynar, Beschoky, and others from the deposits of the different horizons/levels of this formation they were assembled: *Eospirifer radiatus* Sow, *Atrypa reticularis* var. *depressa* Bor., *Delthyris elevatus* Dalm., *Dolerorthis* cf. *rustica* (Soq.), *Eospirifer interlineatus* Sow., *Encorinurus punctatus* Wahl, *Halysites* ex. gr. *catenularia* Linne., *Agetolites mirabilis* Sok., *Sapporipora favositoides* Ozaki., *Palaeohalysites* cf. *escharoides* Fischer-Benson. On the basis of the enumerated above organic remainders/residues, defined by T. B. Rukavishnikova (brachiopods) and N. V. Poltavtseva (tabulate corals), the age of formation is established/installed as by Llandovery and Wenlock.

The Balyktinsk formation in the Chingiz range region, beyond limits of the Semipalatinsk region, on fauna is dismembered to two members: lower - predominantly sedimentary of Llandoveryan stage and upper - effusive - Venloksk stage.

The Donenzhal'sk formation ' has comparatively small development

and composes sections to the east of mountains of Donenzhal, Dogalan, etc.

FOOTNOTE <sup>2</sup>. The Donenzhal'sk formation of lower - upper Silurian is isolated on Donenzhal Mt. (northern spurs of the Chingiz range) by S. M. Bandaletov in 1957. The information about it is published in the theses of reports "Conference on the unification of the stratigraphic diagrams of the pre-Paleozoic of eastern Kazakhstan" (Alma Ata, 1957).  
ENDFOOTNOTE.

This formation, which contains the horizon/level of basal conglomerations in the base, will lie with the angular disagreement on the deposits of lower Karadok and older formations. In formation are included: greenish-gray less frequently less frequent red-colored polymict sandstones, aleurolites, clay shales, conglomerations, calcareous sandstones and limestones, which contain fauna. In the upper part of the formation appear dark gray amygdaloidal diabasic porphyrites, violet albitophyres and their tuffs/tufas. The thickness is approximately 900-1500 m.

The age of the formation, as they are upper Wenlock - bottoms of Ludlow, is set according to numerous mineral resource organic remainders/residues, assembled from its deposits in 1957 by author in region of Dogalan mountains and in 1955-1956 by M. B. Mychnik in the Donenzhal mountains. Is given below a list of this fauna:

*Isorthis cf. szainochai* Kozl., *Nucleospira pisum* Sow., *Stropheodonta belajevi* Bor., *Naliukinia kazachica* Bor., *N. rhomboidalis* Bor., *Eospirifer radiatus* Sow., *Delthyris kasachstanica* Bor., *Mutationella podolica* Kozl., *Favosites jerbøsi* Edw. et H. var. *discoidea* Roem., *F. jerganensis* Ruch., *Heliolites interstrikatus* L., *Calastylis aff. deliculata* Kjerulf., *Anterolites septosus* Sok., *Pachydictya ex gr. crassa* Hall., *Encrinurus punctatus* Wahl.

(determination of the brachiopods was fulfilled by M. A. Borisyak and by T. B. Rukavishnikovoy, the trilobites - by M. N. Koroleva tabulate corals - by N. V. Poltavtseva).

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In the Zaysan-Irtysh intra-geosyncline in limits of the Semipalatinsk region Silurian formations are encountered only in nucleus/kernel of the Charskiy internal second-order geanticline. In the Silurian deposits of this section are included: multicolored siliceous schists, argillites, jaspers, amygdaloidal porphyrites and their tuffs/tufas, sericite-chloritic and marl schists, and also lenses of limestones with the fauna. All these rocks are greatly changed and sheared. The visible thickness of Silurian deposits is more than 200 m. The age of these deposits is defined Silurian on the obtained in them mineral organic remainders/residues: *Pholidophyllum tabulatum* Last., *Ricnostillum quelensis* Whitcaves, *Halysites* sp and brachiopod, assembled in 1932 by A. P. Kalik.

Late Caledonian intrusive complex of species/rocks composes in the Semipalatinsk region fine/small intrusive bodies and veins/strands, which break through deposits of Silurian and older rocks are encountered very rarely. In complex are included: the plagiogranite, plagiogranite-porphyries and quartz diorite. The age

of these species/rocks is defined conditionally as Late Caledonian.

Devonian deposits are widely developed in territory of Bayanaul-Chingiz mobile block and rarely they are encountered in limits of Zaysan-Irtysh intra-geosyncline, where anticlinal structures usually compose. Among these deposits are isolated: Kaydaul'sk formation (lower and middle Devonian), deposits of average/mean Devon, Frasnian and Famennian tiers.

Deposits of Kaudaul'sk formation are sufficiently widely developed in territory of Bayanaul-Chingiz mobile block and rarely they are encountered in limits of Zaysan-Irtysh intra-geosyncline (Koyandinsk anticlinal). This formation, which contains the thinned out horizon/level of basal conglomerations, will lie with the the angular unconformity on the faunistically described deposits of upper Silurian (Donenahal'sk formation) and the more ancient formation/educations. Kaudaul'sk formation are included: quartz and basoquartzite albitophyres, porphyries, orthophyre and their tuffs/tufas, and also quartz, hornblende, pyroxenic and diabasic porphyrites their tuffs/tufas, the more rarely thinned out horizons/levels of the clay shales, tufagenic it is sandstone and conglomerations. It is necessary to note that in the Zalyan-Irtysh intra-geosyncline (Koyandinsk anticlinal) the section/cut of the described formation somewhat changes: in its composition the content of porphyrites and their tuffs/tufas sharply increases; during the advance from northwest to the southeast in the section/cut of this

formation the limestones with the fauna appear. Thickness of formation is approximately 1200-1800 m.

For the described formation rapid facies changeability of species/rocks on their incidence/drop and stretch and presence of subvolcanic intrusions, genetically connected/bonded with this formation, is characteristic. The age of Kaydaul'sk formation is determined by its stratigraphic position in the overall section/cut of region. Lower boundary of formation is the faunistically described Donenzhal'sk formation, on which Kaydaul'sk formation will lie with the the angular unconformity. As upper boundary of this formation serve overlapping it with the angular disagreement the faunistically described deposits of Frasnian stage.

In limits of Zaysan-Irtysh intra-geosyncline age of Kaydaul'sk formation is defined conditionally as lower and middle Devonian. On what deposits the formation will lie it is not established, whereas are overlapped it with the angular disagreement the faunistically described Tournai formation/educations. In the eastern spurs of the Akzhal mountains in the weak lens of the changed limestone M. M. Marfenkova in 1955 gathered poor safety of the fauna: *Atrypa* sp., *Schisophoria* sp., *Spirifer* sp., on the general/common appearance indicating the equipment of limestones with Devon, excluding, according to determination of L. I. Kaplun, the Famien stage.

Deposits of the middle Devonian, according to data of G. I. Sokratov, are widely developed in the Charskiy internal second-order geosyncline, where they, as M. V. Muratov notes, have in base horizon/level of basal conglomerations and with angular unconformity will lie on Silurian formations. In these deposits diverse porphyrites and their tuffs/tufas with the interlayers of motley siliceous schists, jasper-quartzites and gray limestones with the fauna are included mainly. Besides species/rocks indicated above, M. V. Muratov notes in the composition of the deposits of middle Devonian the clay shales, tuffstones and keratophyres.

For rocks of described age rapid facies changeability on incidence/drop and stretch is characteristic. Their thickness is measured by many hundreds of meters, possibly, by the units of kilometers. The age of these deposits is defined as middle Devonian on the obtained in them mineral organic remainders/residues:

*Columnaria disjuncta* Whiteaves, *Productus arcticus striatus* Hall., *Atrypa aspera* Schloth., *Pentamerus globus* Brown., *Rhynchonella subcardiformis* Schnur., *R. princeps* Barr., *Spirifer ex gr. obolites* Barr.

This fauna is gathered in 1932 by N. M. Padurov of the described deposits southeast, and A. M. Kalik - southwest of the settlement of Andreyevka and by A. I. Zakaldaev - in the region of the mine of Vera-Char. The determinations of fauna are executed N. V. Litvinovich.

Deposits of Frasnian stage have limited propagation in the Semipalatinsk region. The formation of these deposits with the

horizon/level of basal conglomerations in the base will lie with the angular disagreement on the Kaydaul'sk formation. In the wings of Charskiy internal second-order geosyncline (according to the data of M. V. Muratov) it accordingly, also with the conglomerations in the base, will lie in the middle Devonian. In the formation of Frasnian stage are included: greenish-gray or brownish red tufagenic and polymict sandstones, clay, siliceous-clay, mica-siliceous and chlorite-clay-lime schists, horizons/levels of conglomerations, of siliceous rocks and rare weak horizons/levels of limestones, albitophyres, porphyrites and their tuffs/tufas. Thickness of approximately 900-1000 m.

To the Frasnian stage these deposits are related on mineral organic remainders/residues containing in them:

*Spirifer audaculus* Con., *S. ali*  
Nal., *Cyrtospirifer cf. achmet* Nal., *C. cf. murchisonianus* Kon., *Elyt-*  
*ha nudifera* Roem., *Pteridorachis* sp.,

by the assembled in 1954 author from the limestones it is sandstone (left bank of river Ashchisu, in three kilometers to southwest from the mountain Bidaik). Determinations of fauna are executed by L. I. Kaplun, flora - M. A. Senkevich.

Deposits of Famen stage have extremely limited propagation. They compose the fine/small synclinal structures, usually broken by disjunctive disturbances, in the southwestern and northwestern parts of Bayanaul-Chingiz mobile block.

In Zaysan-Irtysh intra-geosyncline within limits of described region deposits of Famennian stage they are absent, being encountered only over area of Bayanaul-Chingiz mobile block in the form of small molded edges/gulfs in region of Arkat mountains and in southeastern part of Archaly mountains. These deposits with the small angular disagreement will lie on the deposits of Frasnian stage and the more ancient formation/educations. They are by the limestones of yellow and gray color, silicified by banded marls and calcareous sandstones. In the base of the deposits of Famen stage aleurolites and fine-pebbled conglomerations rarely are encountered. Thickness of Famen deposits in the limits of the Bayanaul-Chingiz mobile block 200-300 m, and in the region of the Arkat mountains and Archaly - 50-55 m.

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These deposits relate to the Famen stage by the accordingly assembled in them in 1957 author in the eastern spurs of the Archaly mountains to the mineral organic remainders/residues:

*Cyrtospirifer sulcifer* (H. et Cl.) *C. archiaci* Murch.,  
*Lamellispirifer posterus* Hall., *Cyrtospirifer calcaratus* var. *quadrata*  
Nal., *Plicatifera* cf. *praelongus* var. *simplicior* Whidb.

Fauna was determined L. I. Kaplun.

Coal deposits in territory of the Bayanaul-Chingiz mobile block in the Semipalatinsk region have limited propagation and are seemed species/rocks of tour and lower to visa.

Deposits of tour compose fine/small synclinal structures lie in



accordance with deposits of Famennian stage. In a Bayanaul-Chingiz zone these formation/educations are encountered usually to the southwest from the Kalbo-Chingiz fault at the significant distance from it. They are by yellowish gray limestones, silicified by marls and calcareous sandstones with the seams of tuffites and fine-fragmentary tuffs/tufas of acid composition; the latter in the individual sections, which gravitate towards to an Irtysh-Zaysan geosynclinal zone (st. Aygyrzhal), begin to predominate in the section/cut of formation, displacing limestones. Thickness of formation of approximately 300- 400 m. Its Tournaisian age is set to the mineral organic remainders/residues, assembled in these deposits in 1956 by M. B. Mychnikom northeast of the Karakungey mountains. Given below is a list of the fauna, determined by O. N. Nasikanova:

*Imbrexia* cf. *incertus*  
Hall., *Spirifer* cf. *biplicoides* Well., *S. baiani* Nal., *S. cf. grimesi* Hall.,  
*Tylothyrus* cf. *laminosus* McCoy, *Athyris lamellosa* L'Ev., *Spirifer* ex gr.  
*lornacensis* Kon.

Deposits of lower to visa are extended on the whole so is extremely limited as preceding, but nevertheless somewhat wider. In the limits of the Bayanaul-Chingiz mobile block their outcrops are noted east the Dogalan mountains and in the interfluvium to Ayaguz-Ashchisu, where they with those thinning out by the horizon/level of conglomerations in the base accordingly or with the weak angular unconformity will lie on the deposits of tour and the more ancient formation/educations. Lower-Visean deposits in this region are yellowish-gray or greenish-gray heterogranular polymict

sandstones and clay shales, and less frequently, conglomerations. In the bottoms of section/cut the horizons/levels of tuffites, fine-fragmentary tuffs/tufas of acid composition, porphyrites and lens of limestones are encountered and calcareous it is sandstone. In the upper part of the section/cut appear the interlayers of the slate coal and of coals with a thickness of up to 2-3 m, and also limonite concretions and small lenses of siderite. Thickness of these deposits from 300 to 700 m. Their age is established/installed as lower-Visean on the mineral organic remainders/residues. In 1954 by the author east the Kayrakty mountains and in 1956. By M. B. Mychnik on right bank of the river Ayaguz gathered the mineral organic

remainders/residues:

*Dictyoclostus* ex gr. *burlingtonensis* var.  
*djidensis* Nal., *D. ex gr. deruptus* Rom., *Chonetes wissotzkii* Nal.,  
*Spirifer kasachstanensis* Sima Sp. cf. *plenus* Hall., *Imbrexia hassan*  
Nal.

and the rarely encountered plant remainders/residues. According to this fauna, determined by O. N. Nasikanova, these deposits are lower-Visean. With them are connected/bonded the coal manifestations and the small layers of coal in Ayaguza region and in other places.

On this section/cut of Paleozoic period of the Bayanaul-Chingiz zone in limits of the Semipalatinsk region concludes.

Most widely coal deposits are developed in territory of the Zaysan-Irtysh intra-geosyncline. Here among them are separated/liberated six formations: Koyandinsk (Tournaisian), Kokon'sk (lower Visean), Arkalysk (middle and upper Visean),

Kokrektinsk (upper Visean), Bukon'sk (middle Carboniferous) and Maytyubinsk (middle - upper Carboniferous).

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Koyandinsk formation <sup>1</sup> in the form of narrow strip (18-20 km) is stretched approximately on 450 km in northwestern direction along the Kalbo-Chingiz regional fault, which is southwestern boundary of propagation of lower carbon of Zaysan-Irtysh intra-geosynclinal zone.

FOOTNOTE <sup>1</sup>. Koyandinsk formation is isolated in the Koyandy mountains in the northern part of the Abayevsk region of the Semipalatinsk region by the author in 1954; Data about it are published in the theses of reports "Conference on the unification of the stratigraphic diagrams of the pre-Paleozoic and Paleozoic period of East Kazakhstan" (Alma Ata, 1957). ENDFOOTNOTE.

Furthermore, the rocks of this formation are encountered in the individual sections (region of mountains of Arkat and Archaly) of Bayanaul-Chingiz mobile block, where the small molded edges/gulfs of Tournai sea went. In the latter case Tournaisian deposits accordingly occur on deposits of Famennian stage, while in others they contain the thinned out horizon/level of basal conglomerations in the base and cover/coat the deposits of Frasnian stage and more ancient species/rocks with the angular disagreement.

In the Koyandinsk formation are included: greenish-gray, reddish

brown sandstones, sometimes with ball separation, fine-pebbled conglomerations, aleurolites and clay shales, and also quartz and basoquartzite albitophyres, quartz porphyries and their tuffs/tufas, spilites, diverse porphyrites and their tuffs/tufas. Among these species/rocks are encountered the small horizons/levels and the lenses of jaspers, argillo-silicon, ferrous-clay and slate coal, micro-quartzites and limestones, which contain fauna. In sandstones and aleurolites the charred flora is encountered. The thickness of Koyandinsk formation of approximately 2000-2650 m.

Age of deposits of Koyandinsk formation is established as Tournai on mineral organic remainders/residues, assembled in 1954-1957 by author of baring east mountains of Ul'ken-Akzhal and Archaly, and also on by right edge of valley of river Ashchisu, in its lower reaches of the river. Is given below the list of the fauna, determined by O. N.

Nasikanova:

*Hemitripa cf. karagandensis* Nekh., *Brachythyris cf. peculiaris* Shum., *Athyris nura* Nal., *Dictyoclostus ex gr. burlingtonensis* Hall., *Spirifer grimesi* Hall., *Imbrexia hassan* Nal., *Tylothyris cf. laminosus* McCoy, *A. lamellosa* L'Ev.

The Kokon'sk formation <sup>2</sup> in the form of strip with width of 20-65 km is stretched approximately on 450 km in northwestern direction to northeast from strip of species/rocks of Koyandinsk formation.

FOOTNOTE <sup>2</sup> Kokon'sk formation is isolated by the author on Kokon' mountain in the northern part of the Abayevsk region of Semipalatinsk

region in 1954; the information about it is published in the theses of reports "Conference on the unification of the stratigraphic diagrams of the pre-Paleozoic and Paleozoic of East Kazakhstan" (Alma Ata, 1957). ENDFOOTNOTE.

It accordingly will lie on the species/rocks of Koyandinsk formation.

In Kokon'sk formation are included: greenish-gray and dark gray heterogranular sandstones, very frequently with ball separation, aleurolites and clay shales, which are rarely encountered small horizons/levels of conglomerations, dolomites, marls and limestones with fauna, and also horizons/levels of siliceous schists, jasper-quartzites, pyroxenic, diabasic and amygdaloidal porphyrites. In the sandstones the charred flora is discovered. Thickness of the Kokon'sk formation of approximately 2500-2900 m. In 1954 N.V. Poltavtseva and M. M. Marfenkova, southeast of the Akzhal mountains from the species/rocks of this formation, gathered the mineral organic remainders/residues:

*Dictyoclostus* cf. *ischimicus* Litw., *D. deruptus* Rom., *Pustula pustolosiformis* Rot., *P. pyxidiformis* Kon., *Pustula* aff. *pustulosis* Phill., *Plicatufera mesoloba* Phill., *Buxtonia denqisi* Nal., *Spirifer plenus* Hall, *S. cf. forbesi* Nord. et Pratt., *Imbrexia hassan* Nal.

According to this fauna, to O. N. Nasikanova's definition, the age of the species/rocks of the Kokon'sk formation is established as lower-Visean (Ishimsk layers).

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Arkalyysk formation' will lie without a visible interruption on

Kokon'sk formation, composing narrow Arkalyksku bank, which in the east-south-east merges with Charskiy belt of rocks.

FOOTNOTE <sup>1</sup>. Arkalysk formation is isolated in the bank of Arkalyk in the northern part of the Abayevsk region of Semipalatinsk region by the author in 1954; the information about it is published in the theses of reports "Conference on the unification of the stratigraphic diagrams of the pre-Paleozoic and Paleozoic period of East Kazakhstan" (Alma Ata, 1957). ENDFOOTNOTE.

In the territory of Arkalyksko-Charskiy zone the crumplings of the deposit of the described formation burst open along the deep fault by the lenticular bodies of ultrabasite. Into its composition enter: bluish-gray, green and dark red aleuropelites, clay, clay-calcareous, micaceous-clay and siliceous schists, and also multicolored jasper-quartzites and quartzites, which are rarely encountered greenish-gray polymict and calcareous sandstones, light grey limestones, marls and the large/coarse thinned out horizons/levels of spilites, diabasic and amygdaloidal porphyrites, also, from tuffs/tufas. Ash tuffs of albitophyres are very rarely noted. By sections from the section/cut of formation fall out siliceous schists or basic effusions. Thickness of Arkalysk formation of approximately 1300-1500 m. In 1954 the author, N. V. Poltavtseva and M. M. Marfenkova in a whole series of the points/items of the northern slope of the bank of Arkalyk gathered the mineral organic remainders/residues:

*Cancrinella*  
*undata* De fr., *Marginifera subcarbonica* Leb., *Buxtonia* cf. *scabriculus* Mart., *Krotovia spinulosa* Sow., *Productus productus* Mart., *P.* cf. *subcarbonarius* Sar., *Plicatifera ferganensis* Jan., *Echinoconchus subelegans* Thom., *Plicatifera ferganensis* Jan., *Echinoconchus subelegans* Thom., *Plicatifera mesoloba* Phill., *Linoproductus* cf. *jagovkini* Nal., *Spirifer trigonalis* Mart., *S.* cf. *triangularis* Mart.

According to the given list of the fauna, defined by O. N.

Nasikanova, the age of the Arkalyksk formation is established as average and upper to visa. With the siliceous rocks of the described formation the commercial layers of manganese and cobalt are connected/bonded. The Novotaubinsk limestones of Arkalyksk formation are used for the kilning of lime and for the production of cement.

Over area of Arkalyksko-Charskiy zone of crumpling, sometimes and in other parts of Zaysan-Irtysh intra-geosyncline are encountered species/rocks of the ultrabasite O upper-Visean intrusive complex. They leave to the topographic surface in the form of the small steeply dipping lenticular bodies, usually timed to the deep breakings. In complex are included: the serpentinous peridotites of the phylum/type of harzburgite, in a smaller quantity pyroxenite, gabbro, diorite, quartz diorite and different dioritic porphyrites. The formation of rocks of the complex proceeded consecutively/serially: from the ultrabasic to the more acid.

Charskiy region with species/rocks of this complex layers of chromite, nickel, cobalt and magnesite are connected/bonded. The ultrabasitic intrusive complex of species/rocks breaks through the Arkalyksk formation of middle and upper Visean and more ancient formation/educations and it transgressively overlaps with Kokpectinsk

formation to the Visean-Namurian with the pebbles of ultrabasite in the basal conglomerations.

The Kokpektinsk formation occupies central(axial) part of Zaysan-Irtysh intra-geosyncline; furthermore, by its species/rocks are folded small superimposed synclinals, elongated in northwestern direction into boundary southwest of part of this zone. This formation consists in its base the thick horizon/level of basal conglomerations and will lie on the washed away surface of Arkalyksk formation and the more ancient formation/educations, and also on the ultrabasite with the angular disagreement.

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In the Kokpektinsk formation are included: fine-grained, polymict, tufagenic and quartz sandstones, in smaller quantity clay, argillo- silicon, carbonate-chlorite-siliceous and carbonaceous-clay schists, horizons/levels of coal, conglomerations and fine/small lenses of marls and limestones with fauna. In the individual sections the horizons/levels of tuffites, tuffs/tufas, albitophyres and paleo-andesites are encountered. In the sandstones the fauna and the flora of a good safety is encountered. The thickness of the Kokpektinsk formation of approximately 1600-2000 m.

Age of formation as upper to visa - Namur is set to those assembled in 1954-1957 from these deposits by author, M. M. Marfenkova and N. V. Poltavtseva in the Mukur r. region, south



mountains of Del'begetey south of Lake Zhanan, also, in picket of Chule-Uzek to mineral organic remainders/residues:

*Marginifera subcarbonica* Leb., *Cancrinella undata* De fr., *Productus* cf. *concinus* Sow., *Spirifer* cf. *trigonalis* Mart., *Goniatites* ex gr. *striatus* Sow., *G. orientalis* Libr., *G. cf. irtysheensis* Libr., *Phillibole* cf. *sprathensis* R. et E. Richter, *Angaropteridium cardiopteroides* (Schmaltz) Zal., *Cardiopteris kokpektensis* Pad.

Determinations of fauna and flora were produced: O. N. Nasikanova (brachiopods), L. S. Librovich (Goniatity), Z. A. Maximov (trilobites) and by M. I. Radchenko (flora).

According to M. I. Radchenko, on flora this formation corresponds to Ostrogsok horizon of Kuznetsk Basin. Probably, with this formation is connected/bonded the formation/education of the layers of coal in Kokpekti settlement region.

The Bukon'sk (Tassubaybukon'sk) formation will lie according (in region of mountains Del'begetey) or sometimes is transgressive (region settlement of Kokpekti, according to G. I. Sokratov) on deposits of Kokpektinsk formation. The deposits relating to it occupy the central (axial) part of the Zaysan-Irtysk intra-geosyncline. In this formation are included: light- or dark gray heterogranular sandstones, aleurolites, clay shales with the horizons/levels of conglomerations and argillo-calcite. In the individual sections quartz albitophyres quartz porphyries, plagioporphyrites, horizons of tuffs, tufagenic sandstones, conglomerations, combustible and slate coal, the layers of coal and siderite are encountered. The thickness of formation according to the data of some researchers of

approximately 500-850 m, and according to the data others - is two times more.

Age of Bukon'sk formation is defined as of Middle Carboniferous on the basis fact that it accordingly will lie on Kokpektinsk formation and in its rocks there are contained, according to determination of M. I. Radchenko, the flora:

*Angaridium potoninii* (Schm.) Zal., *Angaridium submongolicum* Neub., *Paracalamites* sp., *Angaropteridium buconicum* Tschirk., *A. grandifoliolatum* Zal., *Noeggerathiopsis Theodori* Tschirk. Zal.

This flora is gathered in 1957 by author and M. I. Radchenko south of the Del'begetey mountains. Flora, as M. I. Radchenko notes, is characteristic for the Mazurovsk horizon of the Balakhonsk formation of the Kuznetsk Basin. Besides flora, the Bukon'sk formation is encountered poor safety the fauna brachiopod and pelecypod.

G. I. Sokratov separates/liberates analogous formation by the name "Tassu-Baybukon'sk", whose age is defined by it as the Middle- and Upper Carboniferous. Bukon'sk formation on the lithology and the flora can be compared with the carboniferous formation of Kaynamy and the carboniferous formations of the Irtysh group of layers.

Maytyubinsk formation<sup>1</sup> is isolated by G. I. Sokratov for southeastern part of Zaysan-Irtysh intra-geosyncline, where it will lie transgressively on deposits of Bukon'sk formation.

FOOTNOTE<sup>1</sup>. The Maytyubinsk formation is isolated in the Maytyube

mountains on Kalbe by G. I. Sokratov; the information about it is published by M. F. Mikunov in theses of reports "Conference on the unification of the stratigraphic diagrams of the pre-Paleozoic and Paleozoic period of East Kazakhstan" (Alma Ata, 1957). ENDFOOTNOTE.

This formation occupies the central (axial) part of the Zaysan-Irtysh intra-geosyncline.

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Into its composition enter clay, calcareous-clay, carbonaceous and bituminous shale, sandstones, conglomerations, argillo-calcite with pelecypods Antrocosidae and horizons/levels of porphyrites, carbons/coals and the interlayers of siderite. Thickness of formation of approximately 1500 m. In the clay shales, according to data of G. I. Sokratov, the flora of the same phylum/type is encountered, that also in the Tassubaybukon'sk formation, but less diverse. On the flora the Maytyubinsk formation is compared with the Alykayevsk horizon/level of the Balakhonsk formation of the Kuznetsk Basin. The concordant bedding of this formation the the Bukon'sk (Middle Carboniferous), and also the determination of flora indicates it, probably, Middle Upper Carboniferous age.

The Maytyubinsk formation can be compared with the carboniferous formation of Kaynamy and lower carboniferous formation of Kenderlyk.

Upper Paleozoic intrusive cycle, which widely appeared in the

Semipalatinsk region, is intrusions, which are arranged/located mainly in boundary part of the Zaysan-Irtysh intra-geosyncline and in sections of Bayanaul-Chingiz mobile block conjugated/combined with it. Thus, is established the undoubted connection/communication of these intrusions with the moving elements of the earth's crust, where are widely developed numerous deep breakings. The age of intrusions is defined as Upper Paleozoic on the basis of their active contact with the deposits of the average/mean carbon and presence of all species/rocks of these intrusions in the pebbles of the basal conglomerations of upper Triassic of Maykubensk basin, which is located northwest, in the adjacent region.

With manifestation of Upper Paleozoic intrusive cycle is connected/bonded formation/education of three unequal-age polyphase intrusion complexes: early Upper Paleozoic (Zmeinogorsk), Middle Upper Paleozoic (alkaline) and late Upper Paleozoic (Kalbinsk). It is necessary to note that the relative interrelations dependent on age and the sequence of forming these intrusive complexes are established/installed clearly and reliably. In spite of the planned petrogeochemical connection, each of these complexes clearly is distinguished by the age, their bedding, chemical and mineralogical composition, and also by the confinement to it of the specific complex of useful minerals.

Early Upper Paleozoic intrusive complex of species/rocks on form and bedding corresponds to plicated structure of its containing

species/rocks. The largest/coarsest studied massifs of this complex are: the Archalinsk, Kyzyl-Adyrskiy, Kokon'sk, Uytassk, Al'dzhansk, Shoptykul'sk, Dzhaman-Koytassk and a whole series of others. In this intrusive complex several varieties, which arose during the unequal-age phases of intrusive activity, are separated/liberated, moreover this regularity is planned: the more the rocks are acid, the younger they are. In this complex they are included: the I phase - gabbro, quartz gabbro, diorite, syenite and syenite-diorites; the II phase - granodiorite, plagiogranites, granosyenite, tonalite, quartz monazite; III - phase - coarse-grained porphyritic granites; the IV phase - trondhjemites and fine-grained porphyritic granites. The veins/strands of granite-porphyrries, granodioritoporphyrries, syenite-porphyrries, granosyenite-porphyrries, dioritic porphyrites, lamprophyre and diabases are even later, and less frequent are the aplites and aplites and pegmatite.

With hydrothermal activity of these intrusions is connected/bonded formation of layers of gold, scheelite, copper, polymetals and others useful minerals, and also ore manifestations of titanium and antimony. Lower boundary of early Upper Paleozoic intrusive complex dependent on age is planned on its active contact with the species/rocks of the Bukon'sk formation of average/mean carbon. Determinations of the absolute age of the species/rocks of this complex by argon method from the old decay constant give on 7 tests/samples 230-253 mln. years.

Tests/samples are selected in 1955-1957 by the author and are determined in 1958 by T. P. Semenova in the laboratory of the absolute age of KIMS.

Upper carbon - lower Perm' conditionally includes species/rocks of Semeytausk formation<sup>1</sup>, which comprise two massifs in Semeytau mountains and Bestau.

FOOTNOTE<sup>1</sup>. The Semeytausk formation of upper carbon - lower Perm' is isolated in 1954 by the author in the Semeytau mountains, that are located west Semipalatinsk. The information about it is published in the theses of reports "Conference on the unification of the stratigraphic diagrams of pre-Paleozoic and Paleozoic period of East Kazakhstan" (Alma Ata, 1957). ENDFOOTNOTE.

The formation/education of this effusive formation is connected/bonded with manifestation of one of the phases of Hercynian diastrophism on the large/coarse breakings of northwestern stretch in the internal saggings/deflections Zaysan-Irtysh intra-geosyncline. The weakly dislocated rocks of Semeytausk formation will lie almost horizontally with the sharp angular disagreement on the Kokrektinsk formation of Namur and all formations of average/mean carbon. In the formation are included pale-raspberry-colored orthophyre pinkish-brown, in a smaller quantity quartz orthophyre, anorthoclase and quartz porphyries, andesite porphyrites and obsidian. The thickness of Semeytausk

formation is approximately 300 m. The age of Semeytausk formation is not accurately established/installed and is received as conditionally Upper Carboniferous - Lower Permian on the basis of the fact that it overlaps with the sharp angular unconformity to the Kokpektinsk formation of Namur and formation of average/mean carbon and it bursts open by average/mean and late Upper Paleozoic intrusive by complexes. Determinations of the absolute age of the species/rocks of the Semeytausk formation by argon method from the old decay constant are shown on by two tests/samples 220 and 227 millions. The years of test/sample they are selected in 1955 by the author in the southern part of the Semeytau mountains and they are determined in 1958 T. P. Semenova in the laboratory of the absolute age of KIMS. The volcanic glass encountered in this formation is a good construction material and can be used as the easy hydraulic additive to cement and during the production of the lightened construction bricks.

Lenticular, vein-like and boss-shaped bodies of species/rocks of average/mean Upper Paleozoic intrusive complex are timed to tectonic breakings. The most studied large/coarse massifs of this complex are: Keregetas, western part of the mountains of Andygatay, Korgemtas, Batlak, Verkhneespinsk, and a number of of smaller ones. The rocks of the described complex were formed into several unequal-age phases of intrusive activity, moreover the following regularity is planned: species/rock it is finer-grained and the acid, the younger it is. In this complex they are included: I phase - coarse-grained or large-prophyricide alkaline granosyenite, quartz syenite, less

frequently, syenites; II phase - coarse-grained or large- prophyricide alkaline granites, sometimes with the pegmatoid structure; the III phase - fine-grained, frequently porphyritic alkaline granites, sometimes with the pegmatoid structure. By the latter were formed the veins/strands of alkaline granite-porphyry, syenite-porphyry and pegmatite, the more rarely encountered veins/strands of aplite and lamprophyre. With the hydrothermal, auto-metasomatic (albitization) and pegmatitic activity of this intrusive complex is connected/bonded the formation of the layers of rare elements, and also tin and molybdenum.

Lower boundary of species/rocks of average/mean Upper Paleozoic intrusive complex is determined by active contact with species/rocks of Semeytau formation of conditionally upper carbon - lower Perm' and with species/rocks of early Upper Paleozoic intrusive complex.

Conditionally Perm' includes the Sardzhal'sk (Kyzylkiisk) formation, isolated by G. I. Sokratov in southeastern part of Zalyan-Irtysh intra-geosyncline (mountain Saradzhal'sk, Karadzhal'sk and of Tassubay).

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This formation will lie with the the angular unconformity on the surface of the washed away species/rocks of Maytyubinsk formation and the more ancient formation/educations. Into its composition green, violet, dark gray to the blacks of diverse composition porphyrites and



tuff breccias enter. Thickness of Sardzhal'sk formation to 200 m. In 5 km to northwest of the village of Shegelek, G. I. Socratov separates/liberates two necks, which, probably, are the traces of channels, on which occurred the effusion of the lavas of the porphyritic cover of the described formation.

Late Upper Paleozoic intrusive complex of species/rocks, which was being formed on weakened and tectonic breakings, composes concentric annular intrusions, lenticular, boss-shaped, laccolith-like and harpolith-like bodies. The most studied large massifs of this complex are Edrey, Koytas, Mayli-Kara, Deglen, Dogalan, Arkat, Karakul'tas, Kandygatay. The species/rocks of the described complex are characterized by a uniform composition, but they were formed into several unequal-age phases of magmatic activity. In this case here was observed the same regularity, as for the average/mean Upper Paleozoic complex, namely: species/rock it is finer-grained and the acid, the younger it is. In the described complex they are included: the I phase - coarse-grained, sometimes porphyritic leucocratic boundaries, which rarely approach granosyenite (Arkatsk massif); the II phase - medium-grained, sometimes porphyritic alaskite, leucocratic or biotite granites; the III phase - fine-grained, sometimes porphyritic alaskaite and aplite-like granites. By the latter were formed the veins/strands of granite-porphyry, aplite and pegmatite, in a smaller quantity of lamprophyre and quartz dioritic porphyrite. With the hydrothermal and auto-metasomatic activity of this intrusive complex the formation/education mainly of the layers of tin, tungsten,

molybdenum, etc., and ore manifestations of rare elements is connected/bonded.

Lower boundary of late Upper Paleozoic intrusive complex dependent on age is determined by its active contact with species/rocks of the Sementausk formation of conditionally upper carbon - lower Perm' and with species/rocks of average/mean Upper Paleozoic intrusive complex. According to data of G. I. Sokratov, the rocks of Kalbinsk intrusive complex (late Upper Paleozoic) in Kalbe the deposits of the Sarzhal'sk formation of conditionally Permian age break through. The upper age boundary of the late Upper Paleozoic intrusive complex is determined by the presence of the species/rocks of this complex in the pebbles of the basal conglomerations of the ret-Lias carboniferous deposits of Maykubensk basin, in the region adjacent to northwest. The determinations of the absolute age of the species/rocks of late upper Paleozoic intrusion complex by argon method from the old decay constant show on seven tests/samples 215-228 mln. years (massifs of Edrey and Dogalan). Tests/samples are selected in 1955-1957 by the author and are determined in 1958 by T. P. Semenova in the laboratory of the absolute age of KIMS.

Deposits of Mesozoic age in the Semipalatinsk region are crust of weathering, which is developed on all paleozoic species/rocks, including on serpentinous ultrabasite in limits of the Charsk zone of crumpling. As a result of the subsequent wash-out the crust of

weathering was preserved only in the individual sections, sometimes hidden under younger formation. On the sedimentary, effusive and intrusive rock the crust of weathering is mainly kaolin-like and structural clay-like formation/educations, and also opal-Calcedonian rocks. Kaolin clays sometimes are used as fireclay raw material (May mine). The thickness of the kaolin-like crust of weathering reaches 25 m. The crust of the weathering of ultrabasite consists of birbirites with nests and lenses of nontronite, magnesites and silicifide serpentinites.

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Its thickness to 50 m. With the crust of the weathering of ultrabasites is connected/bonded the formation/education of minable deposits of nickel, cobalt, magnesite, also, sometimes of the brown hematite.

Tertiary deposits are developed in territory of described region sufficiently widely, but it is uneven, especially in its southeastern and northwestern parts. The deposits of this age are divided into four formations: Saksaul'sk<sup>1</sup> (upper eocene), Aral (lower and average/mean miocene), Pavlodar (average/mean and upper miocene) and the deposit of upper neogene.

FOOTNOTE<sup>1</sup>. We have in mind not the sea Saksaul'sk formation, but, analogous to it, the continental formations. ENDFOOTNOTE.

Saksaul'sk formation is encountered in northwestern part of the Semipalatinsk region by larger part in the form of eluvial disintegrations of blocks and rarely it leaves in radical baring. Saksaul'sk formation is yellow, light grey and yellowish-brown drain sandstones and sugar-like quartz sandstones, gritstone and sedimentary breccia, in which are encountered plant remainders/residues. In bottoms of the formation reddish-brown-black porous ferrous sandstones are noted. Thickness of the deposits of this formation is up to 8-13 m. On the basis of position in the section/cut of the Paleogen of flora and cryptogamous-pollen complex of those containing in the formation, its age is determined by V. S. Kornilova as upper Eocene.

Aral formation has sufficiently wide development in the Semipalatinsk region, after lying in wide valleys. Into its composition green-colored clays with the interlayers of sands enter mainly, it is sandstone, friable marls, pebbles and the lenses of gypsum. The thickness of Aral formation reaches 56-70 m. Its age is established as lower and middle Miocene on the basis of the definition of the remainders/residues of the bones of mammals gathered in 1956 by Yu. A. Stolyarov on on the right bank of river Karaganayryk and defined by V. S. Bazhanov as *Anchitherium aurelianense* Cuv., Cervidae gen. ind., Cervidae (*Cervavitus*), Rhinocerotidae gen. ind. With the the Aral gen. ind., Cervidae (*Cervavitus*), Rhinocerotidae gen. ind. with the Aral formation the formation/education of the layers of gypsum (Borly) is connected/bonded.

Pavlodar formation, which has smaller development in described region, than Aral, also will lie in wide valleys. Into its composition enter mainly red-colored gypsum-bearing clays, sands, sandstones and pebbles. The thickness of Pavlodar formation reaches 67 m. In age it relates to the average - upper miocene on the basis of the remainders/residues containing in its deposits of the bones of hipparion fauna.

Deposits of upper neogene are encountered in limits of Bayanaul-Chingiz mobile block (valley of river Ashchisu). On rocks of Pavlodar formation and the more ancient formation/educations with the wash-out fine-pebbled conglomerations and heterogranular sandstones of lower-Gobi appearance will lie. The thickness of these formation/educations is not less than 20-30 m. Their upper-Neogene age is set to the mineral organic remainders/residues gathered from these deposits in 1955-1956 by M. B. Mychnik and E. K. Vil'tsing to the south of the Dhelandy mountain. Among them, regarding V. S. Kornilova, there is located the flora: *Arundo Loeppertii* Muenst, *Poacitos* sp. A cryptogamous-pollen analysis of deposits, produced by S. M. Blyakhova, indicates the presence in them of grains of the pollen: Cupressaceae, Betulaceae-Juglandaceae, Chenopodiaceae, Leguminosae, *Artemisia*. Last/latter forms correspond to neogene, possibly, its upper part, but as a result of the fact that these formation/educations will lie on the Pavlodar formation of average/mean and upper miocene, it is probable, them should be considered Pliocene.

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Quaternary deposits are very widely developed in the Semipalatinsk region. Their thickness majority of the cases small, 0.5-2 m, although in some lengths it reaches 40 m. In the described region a placer of gold, rare metals, titanium and rare elements, connected with the quaternary deposits, are encountered. Furthermore, quaternary deposits here are frequently used as building materials.

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